The concept of Waste and its use in information system design

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Abstract

No system is 100% efficient and so by definition produces waste. Whilst the concept of waste and waste minimisation is entrenched in the industrial systems sector eg with the Just In Time philosophy, it is still not widely used in others such as business information systems. Waste is not confined to material loss, but also to such things as time wasted, or to more intangible concepts such as loss of morale. In fact, any unwanted system output is waste. The identification of all but the most obvious of these by system designers can be difficult because they are designing the system using their own perceptions of what is a "good" output and what is waste. Waste can be "in the eye of the beholder". The definition of waste in all but simple systems can itself be a contentious issue. One person's waste can be another's benefit.

The identification of waste can itself be illuminating if system methods are being used in resolving issues where perceptions of the problem space are not agreed upon, ie "soft" problems. The "world views" of the stakeholders in the problem can just as easily be identified by what they regard as waste as it can from what is regarded as desirable. In fact, it can bring out entrenched biases more clearly.

Whilst most system techniques consider the expected and desired outputs of a system, few consider the unwanted ones. The system itself is, of course, just a concept but the classification of waste can identify paradigms which might otherwise have been hidden in the system definition.

At a more concrete level, the design of information systems can greatly benefit from the identification of unwanted outputs. Designers often become engrossed in productivity, ie expected outputs, but rarely consider the detrimental effects of their system (although the detrimental effects of other systems, eg the one to be replaced, are cited).

Developing a Business Flight Simulator for Learning Organisations

Background

In the Autumn of 1992 a group of academics and UK businesses set up a consortium to research and develop innovative approaches to computer supported collaborative work (CSCW). The consortium is concerned with how to improve the performance of groups of managers, when they have available an "intensely computer supported" work environment. The UK Department of Trade and Industry initiated a CSCW research programme, and out of the 37 proposals put forward, this consortium's bid 'The Business Flight Simulator' (BFS) was one of eight projects accepted. The aim of this paper is to outline the principles behind the BFS, its architecture and operation, and the relationship with Systems Dynamics concepts and software.

Historical perspective

From time immemorial, and certainly for the last 5000 years, managers at all levels have used groups and teams for advisory purposes, for communications purposes, and for decision-making. What is particularly striking about so many of the management meetings of today is that they take place with rudimentary technology - flip charts, white boards and simple overhead projectors. Even the use of computer-based presentations scarcely moves further than the Victorian epidiascope technology. The use of computer technology to support groupwork has scarcely penetrated the great majority of management meetings.

The first major work in this area was carried out by Doug Englebart at the Stanford Research Institute (SRI) in the mid 1960's (Englebart, 1962). His project, concerned with the "Augmentation of Human Intellect", involved supporting meetings of a dozen or so white-collar workers with a mini-computer based collaboration system Augment.

When Xerox set up its Palo Alto Research Centre (PARC) in 1970, it recruited many key staff from SRI. It was therefore hardly surprising that when Xerox developed the world's first personal computer (the Xerox Alto) in 1973, it very quickly became networked, using the early versions of Ethernet. This was Version 1 of Personal Computing: essentially collaborative.

Version 2 of Personal Computing derived from the "home-brew" computing movement of the mid to late 1970's, typified by the Apple 1 and Apple 2 computers. Unfortunately, when IBM launched its PC in August 1981, it chose to go down the Version 2 route. This was an individualistic route, where there was little or no conception of, or interest in, networking the PC.

Since it was the IBM PC that dominated the business desktop in the 1980's, and not the Xerox PC, this commercial dominance of Version 2 has set back the whole area of computer supported group working in business by many years. Not only are there even today still significant technical inconveniences in networking disparate PC-based products, a decade of primarily personal use of PC's has also created work habits that are not geared to group use of IBM-compatible PC's.

So in addressing the question of intensive computer support to managerial groups, there are two preliminary obstacles - one technical, one related to lack of a group perspective in use of computers generally.

Groupware

The general word to describe software for group use is "groupware" (Grief, 1989). There are a variety of definitions which exist for this. One of the longest standing is that from two of the pioneers in using computers for group work in the 1970's - Peter and Trudy Johnson-Lenz (1982). Their definition is both simple and elegant:

"Intentional GROUP processes plus the softWARE needed to support them"

There are now a very wide variety of commercially available groupware products. In Holtham (1993), a matrix was developed to classify these products (Figure 1), based on the business processes - those core activities which cut across departments and job functions - to which groupware can be applied. The axes relate to the level of management process, and the degree of interactivity within the group.

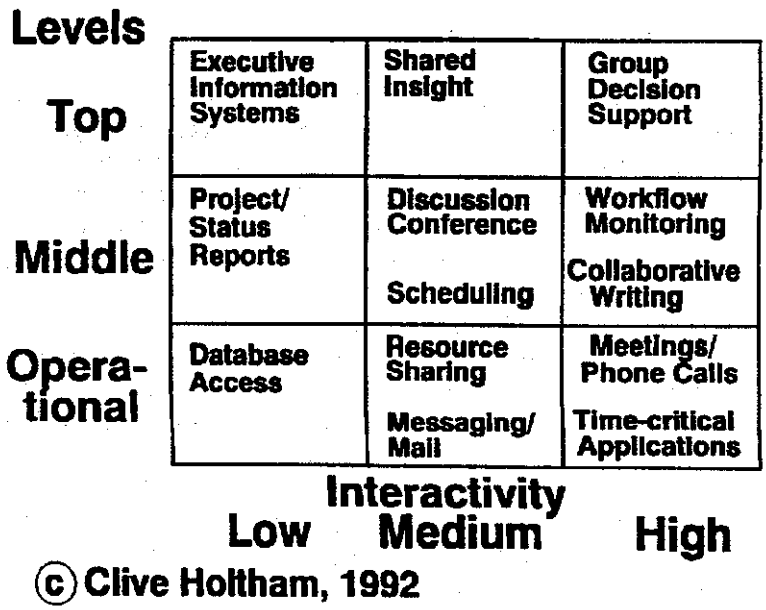

Figure 1: Information processes by pyramid management levels and interactivity

The processes typically supported by the work of systems dynamicists would either be "group decision support" (very interactive group situation) or "shared insight" (somewhat interactive group).

Collaborators

There are five major industrial collaborators in this project:

* ACT Business Systems - project management and consultancy
* Bull Information Systems UK - provision of hardware, networking and systems integration
* Esmerk Ltd - provision of real-time and historic data feeds
* PCL Ltd - technical integration of groupware and information tools
* Touche Ross - process methodology and integration

City University Business School is the lead academic collaborator. An academic steering committee has been created involving three other business schools - Strathclyde, Loughborough and Cranfield. There

are also a number of other industrial collaborators, which comprise a "Collaborative Club." One of these is a distributor of systems dynamics software - the Electric Brain Company.

Operation of the Simulator

The structure of the Business Flight Simulator is summarised in Figure 2.

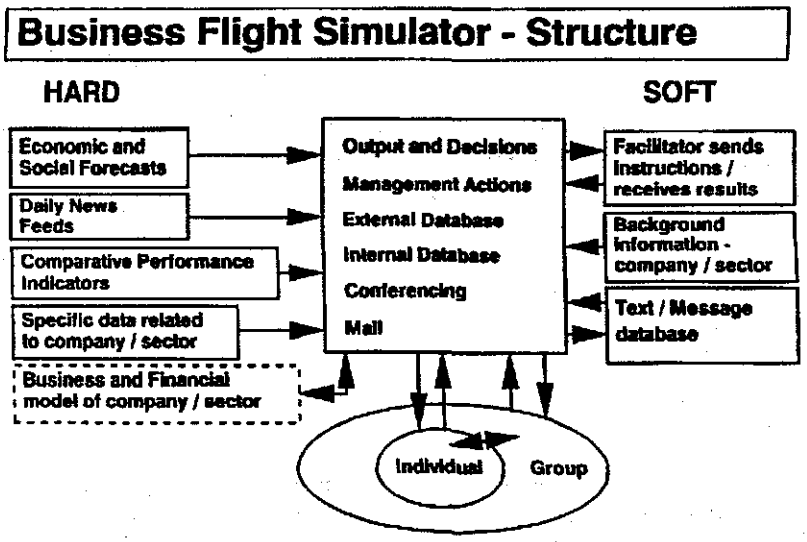

Figure 2

The central core is a local or wide area network, with immediate availability of a variety of existing groupware packages. This network physically supports a group involved in an important piece of collaborative work. This work typically involves access to "hard" data: forecasts, databases, news and information feeds, and financial data. There will be "soft" data also - in informal discussions and controversies.

Group members partly work on an individual basis, synthesising data and brainstorming, and then actively collaborating with colleagues via computer conferencing and electronic mail. Those working in the same place can also use ordinary meetings as appropriate. The aim is certainly **not** to replace all face to face contact by a wholly electronic support environment. A facilitator can introduce additional ideas and challenges at any time. The group will typically need to conclude by producing a policy document or action plan.

Settings

Applications of the BFS involve at least three different settings:

1. Running the simulation on an organisation's own premises over a finite period of time e.g. ½ - 1 day. This is typically a real planning or strategy meeting.

2. Running the simulation as in 1, but with some participants physically remote, interacting for the finite period by electronic methods. In further stages of development there are plans to supplement this with video conferencing links.

3. Running the simulation over an extended period of time, using databases and communications facilities held at one or more central locations, with participants using PC's either at home or at their normal desktop.

The initial BFS has work has been carried out using the "LAN in a Suitcase". This is a portable local area network, using notebook computers, a server with Novell Netware and a variety of groupware packages. The notebooks are connected via parallel port ethernet adapters.

Platforms and core products

Because at the PC level Windows 3 is likely to be the dominant GUI over the period of the study, then it was most appropriate to select tools which are available under Windows 3. But it would be ideal to use tools that could perform across Windows 3, Apple and Unix/X-Windows.

There are several core products, which will be used in many of the BFS test sites. One is Lotus Notes, which provides electronic Mail, computer mediated conferencing (Discussion Databases), an applications development environment and sophisticated access for laptop users.

A second is VisionQuest. This is a real-time electronic brainstorming and voting package. The third core package is Fujitsu Desktop Conferencing (DTC). This enables users on a local area network to share screens, and to create shared "electronic flip charts" superimposed on those screens, which can then be stored within Lotus Notes databases.

Architecture

As the project has developed, the experience of integrating widely disparate systems (all nominally PC, Novell and Windows based) has proved to require a degree of self-imposed consistency lacking in the practical evolution of technologies for these platforms.

To this end it has been necessary to develop three strands of architecture for the project, each currently represented by collaborative working parties of Consortium and Club members: Process architecture; Technical architecture and Information architecture. A fourth group is drawing together the human, social and facilitation issues involved in the project.

Research

The project involves research at several levels. Firstly there is the identification and integration of individual groupware tools or building blocks. There is a need for basic research and development of the methodologies needed for tool integration.

Secondly there is an exercise described here as "process integration" - linking alternative packages of groupware building blocks to the information and communications needs of specific real-life business groups.

There is then a need to apply the tools to the business processes in actual organisations. A number of organisations willing to act as `test sites` have already been identified. An exercise based on use of groupware tools, and which can in at least some respects be repeated across sites, will then be carried out. This exercise will often involve a facilitator, as group processes in business typically are not enhanced solely by the application of technology.

Example - Market Planning

Most business use of groupware currently relates to use of a single package, or to the separate use of at most two or three different packages. The BFS involves the use, either in a single meeting, or over time, of different combinations of groupware products in a structured way.

To take, as an example currently being developed, the market planning process. This may involve several groups -the Board, the Market Planning group (cross-departmental) and the individual department management teams. It would not be unusual for each department to be supported largely by printouts from single-user spreadsheets and, to have traditional"manual" meetings to finalise proposals. The departmental spreadsheets will then be aggregated by the Marketing Strategy Coordinator. The Market Planning Group will then have "manual" meetings supported by printouts, as will the Board.

With the BFS, previously "manual" meetings will now be electronically supported. Any group involved could use networked notebook computers in a normal meeting room with a range of groupware available. Spreadsheets can be examined, but opinions about them should (and recorded) with the Desktop Conferencing software. Brainstorming would be carried out with VisionQuest, and the results fed into a Lotus Notes database that is the available at the end of the meeting (or even during it!) for electronic publication to a much wider group.

It can be seen in this context, that use of a Systems Dynamics package could be an important part of the initial problem mapping, and this could be displayed and refined by different groups as the process unfolds.

Simulation Precedents

There are a variety of approaches which prefigured the Business Flight Simulator. A good general discussion is contained in Lane (1993).

The International Business Negotiation Simulations (IBNS) project, developed by the University of Maryland (Rawson, 1989), involves workshops which allow business executives acting as members of a mock US company, to perform a negotiation (via computer conferencing) of a business venture with their peers from an overseas country.

IMI-Geneva has developed an extensive simulation - the Integrated Management Exercise. This has no pre-digested written case study (Smiley, 1989). There is, however, a vast amount of company and industry data in a computerised information file. This "infofile", based on a real international company, includes not only the "numbers", but also narrations covering the history, background and culture of the organisation plus descriptions of the people within it.

A simulation with similar goals, Proteus, was developed by a consortium of UK universities based on a mainframe. Using funding from the UK Department of Trade and Industry's Applied Technologies in Learning Programme, Manchester Business School has developed this into a local area network based simulation - "Network Proteus".

These (as well as non-computerised games and simulations) clearly provide an important opportunities for more experiential based learning. But even these innovative approaches fall short of the concept of the business flight simulator.

Much closer to this concept is the flight simulator used to train pilots since the Second World War. These have become increasingly expensive and working with them can, for certain purposes, be deemed to substitute for actual flight experience. The flight simulator is a totally artificial environment except for the cabin unit which is a replica of the real aircraft cabin. The simulator provides external graphic displays (the view out of the cabin) which have become increasingly lifelike. A wide variety of weather and terrain options are available. There is a monitoring, recording and assessment system so that student and tutor can replay the flight and analyse what happened.

Even the most sophisticated and expensive flight simulators cannot cope with every possible situation faced, and arguably flying a plane is much more of a "programmable" exercise than running a business - there is no business equivalent of the autopilot, for example.

At the MIT Sloan School of Management, an initial approach like this has been taken with the failed airline People Express. The case developed is actually called the "People Express Management Flight Simulator". Drawing on actual company data, and a variety of planning and forecasting models superimposed on the data, students can use the computer to re-play decision making at People Express, to examine what alternative decisions might have saved the company. The software is systems dynamics based, and is now available under Windows 3.

Types of Simulation

In developing the BFS project a distinction has been made between two types of simulation; firstly "deterministic" and secondly "human interaction."

The great majority of simulation in both a generic and an operational research sense is **deterministic**. It contains some underlying, usually quantifiable model. This could perhaps slightly more accurately be called "model-based". The aviation flight simulator is model based. Such models can involve risk and uncertainty, but there is limited scope for exercises external to the models.

What we describe as a **human interaction** simulation by contrast is not model based. It depends on a group of people exchanging ideas and beliefs in a discussion. Alternatives may be proposed, evaluated and rejected or accepted purely through oral discussion. We have coined the phrase the "Human What-if?" to describe this.

The starting point of the BFS is the human interaction perspective. In so far as it uses model-based tools, these are supplementary inputs into the group interaction. It is possible to carry out BFS sessions with minimal or zero model-based inputs.

The Learning Organisation

There are a wide variety of styles and structures of business organisation. In order to narrow the alternative ranges of such styles and structures, a particular emphasis in the BFS is placed on the "learning organisation" (Garrett, 1989, Senge, 1990, Lessem 1992). Pedler, Burgoyne, and Boydell (1991) define the learning company as:

"an organization that facilitates the learning of all its members and continuously transforms itself."

The traditional hierarchial approach to management is, in many ways, concerned with the management of stability. However, as the environment of business changes increasingly rapidly, as the sources of competition increase rather than reduce, and as the alternative ways of managing increase, then a more flexible style of organisation needs to evolve.

The 'learning organisation' is an approach which supports such flexibility, with an emphasis on continual feedback from experience, regular review of both objectives and operations, all within a managerial philosophy with an emphasis on rich communications, both vertically and horizontally.

The majority of test sites involved in the BFS project will either have explicitly espoused the style of the learning organisation, or will have done so implicitly. However, not all organisations to be examined will fall into this category, as a control group is essential and also because in practice organisations rarely exhibit styles that are of a 'pure' hierarchical or 'pure' learning orientation. So it is essential to be able to review groups working under both styles.

Impact of systems thinking

Some of the basic concepts underlying the project are derived from systems thinking in the classical sense. One of the single most significant influences was the work of Stafford Beer (1981) in relation to warrooms or operation rooms. Beer (see Espejo and Harnden, 1989) now prefers a less militaristic term such as "management centre". To Beer, an organisation needed an information infrastructure and organisational form that were consistent with the Viable Systems Model (VSM). Data collected in sub-systems would be filtered and re-presented at the Policy and Intelligence levels.

Physically, Beer's most famous operations room was that constructed for President Allende in Chile. It is perhaps difficult in retrospect to recall the impact in the early 1970's of hearing of this futuristic room, using specially designed chairs with integral keypads, and innovative wall mounted displays.

The BFS is not attempting to replicate Beer's operations room per se. There is not as yet formal use of the VSM approach in the project, for example. But the BFS does represent an effort, using contemporary information technology, to capture some of the spirit of that room.

Impact of model-based simulations; the BFS and systems dynamics

The initial design of the BFS assumed that most, if not all, of the model-based aspects of simulation would be catered for by spreadsheets, as these are used for such a high proportion of the general modelling carried out in business.

However, some of those involved in the project had been influenced by systems dynamics (Forrester, 1961). There was an attraction to the approach as summarised by Wolstenholme, Henderson and Gavine (1993):

"The Systems Dynamics methodology was designed to examine the behaviour of complex systems over time. It does so by representing the processes, structure, strategies and information flows of systems. A definition of the method can be stated as follows:

A rigorous method for qualitative description, exploration and analysis of complex systems in terms of their processes, information, organisational boundaries and strategies; which facilitates quantitative simulation modelling and analysis for the design of system structure and control."

The major practical problem faced, in early 1993, was that the standard microcomputer package to assist in mapping process structures (iThink (TM)) was then only available on a Macintosh platform.

The perspective changed completely with the launch in 1993 of a new systems dynamics package PowerSim, from the Norwegian Company ModellData. Not only was this explicitly written and tailored to the Windows 3 environment, it also had PC networking capabilities, and was being geared to the management education perspective, for example with the prospect of being able to publish run-time versions of models. Byrknes, Gonzalez & Myrtveit (1993) illustrate well the potential of PowerSim software in a networked management simulation situation.

The availability in Windows of architectural features such as Object Linking and Embedding (OLE) and Dynamic Data Exchange (DDE) enable the BFS project to propose an environment where users can move directly from, for example, a meeting agenda in Lotus Notes to a blank or partly completed systems map. Alternatively, the reverse is also required - to move from a symbol on a systems map to, for example, a spreadsheet, a multimedia object, or a discussion conference about the logic of that part of the map.

Senge, Peter (1990) "The Fifth Discipline" New York, Doubleday

Smiley, Tex (1989) "An Experience in Integrated Management Learning" IMD, 89/1 pp15-18

Wolstenholme, Eric F., Henderson, Simon, and Gavine, Allan (1993) "The Evaluation of Management Information Systems" John Wiley, Chichester